

KamLAND - Kamioka Liquid Scintillator Anti-Neutrino Detector

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KamLAND is a 1000 ton neutrino detector located in the former site of the Kamiokande experiment under Mt. Ikenoyama in Japan. The primary mission of KamLAND is to search for neutrino oscillations using commercial nuclear power reactors in Japan as the source of electron anti-neutrinos. The long baseline (typically 180 km) combined with low neutrino energies (2-6.5 MeV) allows KamLAND to address the solar neutrino problem for the first time under laboratory conditions. The construction of KamLAND began in 1998 and was completed in September, 2001. The commissioning of KamLAND proceeded in stages where the instrumentation of 1325 17-inch photomultiplier tubes (PMTs) was the priority of the first stage. On January 22, 2002, the first stage was complete and KamLAND began twenty four hour per day, seven days per week data taking. By February, 2003, the remaining 554 20-inch PMTs were included in the regular data streams.

The KamLAND group at LBNL was responsible for many major detector components including the front-end electronics (KAMFEE), the “z-axis” calibration source deployment system, and the “off-axis” (4π) calibration source deployment system. In addition, several members of the LBNL group acted as project manager for all US construction efforts and the coordination of all onsite US activities for the first year of KamLAND operations. The KAMFEE system was developed and built at LBNL. Installation of the KAMFEE system began in September, 2001 and by December 2002, all 17-inch PMT channels were instrumented. The KAMFEE’s had numerous fabrication errors made by the outside loading house and a few minor design flaws. These fabrication errors were and design flaws were corrected and by March 2002, KamLAND began acquiring “good” data. The last of the design flaws, which did not affect the reactor neutrino measurement, was corrected in January 2003.

The “z-axis” deployment system was installed in December, 2001 and first deployments of calibrations sources were performed in January, 2002. The deployment of calibration sources with the “z-axis” system is now part of regular KamLAND operations and sources are deployed weekly to monitor the stability of the experiment. Due to the difficulty of the problem, the development the “off-axis” deployment is behind schedule. However, the “off-axis” deployment effort has been recently

invigorated with the addition of new personnel. The “off-axis” deployment system has been restarted with parallel development paths. One of these, an “off-axis” pole solution, is expect to be available for deployment by the end of summer, 2003.

The first year of KamLAND operations was very eventful. Based upon a data sample of about 145 days of data, we published a Physical Review Letter [1] in Jan. 2003 reporting the observation of anti-neutrino disappearance. The neutrino oscillation parameters inferred from this result are consistent with the large mixing angle MSW solution to the solar neutrino problem. At the present time, KamLAND is accumulating data for a detailed analysis of the energy spectrum to search for the spectral distortions that would be a signature of neutrino oscillations. A second solar phase of the experiment is currently under consideration.



FIG. 1: A KamLAND shift operator controls the data acquisition system during a calibration source deployment. The computer on the right controls the position of the calibration source inside of KamLAND.

[1] K. Eguchi, *et al.*, Phys. Rev. Lett. **90**, 021802, (2003).